Geophysical Research Abstracts
Vol. 14, EGU2012-6433-5, 2012
EGU General Assembly 2012

Interplay between water infiltration, metamorphic reactions and strain localization during subduction of gabbro from the basement rocks of the Lofoten anorthosite complex

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Eclogitization of lower crustal rocks occurs during subduction processes. During the prograde segment of subduction cycle and subsequent exhumation, ranges of mineral assemblages are produced under different P-T conditions. In this contribution, we describe the role of water and formation of syn-kinematic mineral assemblages in the ductile shear zone within leucogabbro and in the retrograde equivalent (characterized by alternate bands of mafic and felsic layers) that are separated by a distance of 100-150 meter.

In the undeformed gabbro, Plagioclase (Pl_0), olivine (Ol_0) and orthopyroxene (Opx_0) form the igneous texture. The onset of metamorphism (M_1, 700 ^{0}C, 1GPa) during subduction processes is indicated by growth of metamorphic Opx_1 and Grt_1 corona around Pl_0 and Ol_0. Cm- wide alternating bands of a mixture of Pl-amphibole (Amph) $\pm$ Spl and $Grt_I(M_1)$ – Opx –Omph – Grt $_{II}$ (M_{2A}, 650-750 ^{0}C, $>$ 1.8 GPa) phase mixtures characterize shear zones. Omph overgrow deformed Opx grains (D_1). Clinopyroxene (Cpx) -Pl symplectite ($M_{2B,}$ 600-650 ^{0}C, 1 GPa) occur at the outer rim the Omph. Breakdown of Grt $_{I/II}$to Amph $\pm$ Pl (An rich) $\pm$ Spl with increased water activity form during M_3 metamorphism.

In the retrograde eclogite, the mafic layer is composed of Cpx, sodic Pl and Qtz (grain size 50 μm). Coarse-grained calcic Pl (grain size 50-75 μm) forms the felsic layer. Grt porphyrolcast (eq. Grt $_{I/II}$) with inclusions of Pl and Qtz occur within the mafic layer. A thin layer of amphibole and clinozoisite layer overgrows at the contact between the mafic and felsic layer (600^{0}C, 0.6-0.8 GPa).

In the ductile shear zone, crystallographic data of recrystallized Opx_0 (grain size 20-30 μm) and the relict Opx_0, chemical similarity and the grain size reduction indicate that Opx deformed by at the onset of subduction. The deformed Opx grains show sinistral sense of shear. Although, the fine-grained Pl is expected to show random CPO characteristics of diffusion creep, the strong CPO of Pl is indicative of inheritance of crystallographic preferred orientation from D_1 deformation. The CPO of amphibole suggests that amphibole re-orients by rigid body rotation during deformation, forming aligned (100) planes with opposite shear sense with the Opx_0 defined fabric.

In the retrograde variety, the CPO data of Cpx from the mixed phase layers is consistent with the (010) [001] dominant slip system. However, the CPO data of Cpx is interpreted as oriented growth fabric during diffusion creep. Crystallographic data of recrystallized plagioclase in the mono-mineralic felsic layers indicate (010) [100] as dominant slip system during dislocation creep.

This study indicates that the deformation of the Opx_0in the ductile shear zone occurredat the amphibolite-granulite facies condition with the influx of water. After the static growth of Omph, increase in the water activity promotes the growth of Amph and the deformation after the post eclogite stage (M_3). However, in the retrograde eclogite, the coarser grain size of the minerals (Cpx, Pl) is achieved probably due to water-saturated condition and promotes diffusion creep accommodated deformation.